

## Impact of sea transport on animal welfare: Australian case studies (sea transport of sheep and cattle)

*A.L. Barnes, D.T. Beatty, C.A. Stockman, School of Veterinary and Biomedical Sciences, Murdoch University, MURDOCH WA 6150, a.barnes@murdoch.edu.au*

### Introduction

Cattle and sheep are exported from Australia by sea and form a significant market for Australian animals. For instance, in both 2006 and 2007 over half a million cattle were exported by sea from Australia, with the majority travelling the short journey to Indonesia. Other destinations included other Asian countries and the Middle East; about one tenth of the cattle travelled the “long haul” voyages to the Middle East and North Africa (MLA – Livestock Export Market Outlook Reports Dec 07). There are considerably more sheep transported by sea from Australia, with 3-4 million sent in both 2006 and 2007, the majority of these travelling to the Middle East and North Africa. (MLA – Livestock Export Market Outlook Reports Dec 07).

A number of factors have been identified as impacting on the welfare of animals transported by sea. Norris *et al.* (2003) identified heat stress as a major cause of reduced welfare and increased mortality of cattle transported by sea, and as an important cause of increased mortality of sheep during periods of extreme hot, humid conditions (Norris and Norman 2002). These findings led to research into the physiology of heat stress in cattle and sheep, with a view to finding ways to ameliorate the effects on the animals, such as the provision of electrolytes.

In conjunction with this work, a Heat Stress Risk Management model was developed (Stacey 2003), which used all available data on ships, weather conditions, voyages, and animal factors such as heat stress thresholds for different classes of animals and stocking rate to determine and therefore reduce the risk of a heat stress incident. The heat stress threshold was determined as the prevailing wet bulb temperature at which the animal's core body temperature was 0.5 °C above what it would normally be, and climate room work was conducted to identify that threshold for various classes of animals commonly transported by sea.

### Summary of heat experiments

#### *Methods*

The experiments conducted to investigate the physiology of cattle and sheep in response to hot, humid conditions as experienced on board long haul voyages from Australia to the Middle East have been published previously (e.g. Barnes *et al* 2004; Beatty *et al* 2006, 2007; Stockman *et al* 2006), and the following provides a summary of that work.

Climate controlled rooms were established at Murdoch University where animals could be housed individually or in groups, and subjected to hot, humid conditions similar to the temperature and humidity recorded on live export voyages to the Middle East. Wet bulb

(WB) temperature was used as a standard measure incorporating both heat and humidity, because it was considered that these were the two factors that impacted most on heat loss or accumulation of animals transported by sea. Previous voyage reports indicated that the maximum temperature reached was around 32 °C WB, and that there could be several days at that temperature with often little respite from the heat at night, especially in equatorial regions. Thus, experiments were conducted that exposed the animals to gradually increasing WB temperature, up to a maximum of 32 °C WB for several days.

The animals were monitored stringently while they were exposed to such conditions. Internal temperature sensors were surgically implanted into the abdominal cavity, to provide a real-time, continuous measure of core body temperature and the heart rates, respiratory rates and character, individual feed and water intakes, and frequent blood and urine samples were taken. Six cattle or 18 sheep could be housed in the rooms at a time. Two experiments were conducted evaluating the physiological responses of *Bos taurus* to the conditions, followed by one experiment with *Bos indicus* (Beatty *et al* 2006). Another experiment monitored six Awassi rams and 12 Merino wethers in climate controlled rooms and another six Merino wethers held at prevailing environmental temperatures (Stockman *et al* 2006). These baseline experiments then led to the testing of an electrolyte supplement for cattle, but not sheep, firstly in the climate controlled rooms and then on a commercial voyage (Beatty *et al* 2007).

The data from these experiments and several subsequent ones was also provided to the group developing the Heat Stress Risk Management Model.

### *Results*

#### *Cattle experiments (Beatty et al 2006)*

Figure 1 shows the wet bulb temperature of the climate controlled rooms for the initial cattle physiology experiments. The wet bulb temperatures were achieved at a relative humidity of around 70-80%. The average core body temperature of each group of cattle is shown in Figure 2, which illustrates that *Bos taurus* have a lower heat stress threshold temperature than *Bos indicus*, meaning that *Bos indicus* are more heat tolerant. This was also apparent in other physiological responses of the cattle, with *Bos taurus* developing a faster respiratory rate (Figure 3) and greater subsequent blood gas changes; of note were the changes in blood bicarbonate (Figure 4). The feed intake of the *Bos taurus* reduced as wet bulb temperature increased, resulting in liveweight losses, while most of the *Bos indicus* continued to eat well. Water intake was increased for all three experiments as wet bulb temperature increased.

**Figure 1: Wet bulb temperatures for the climate controlled rooms for the three heat experiments. Each value is the mean of three measurements in the two rooms.**

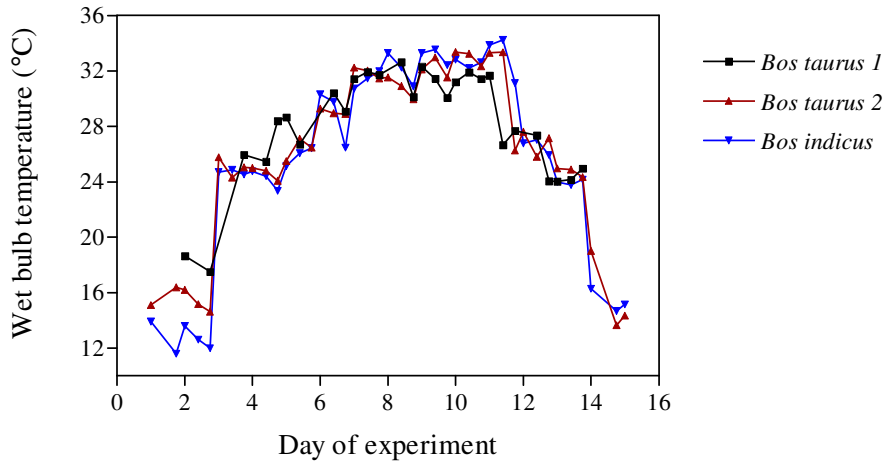


Figure 2: Mean core body temperature of animals in three heat experiments.

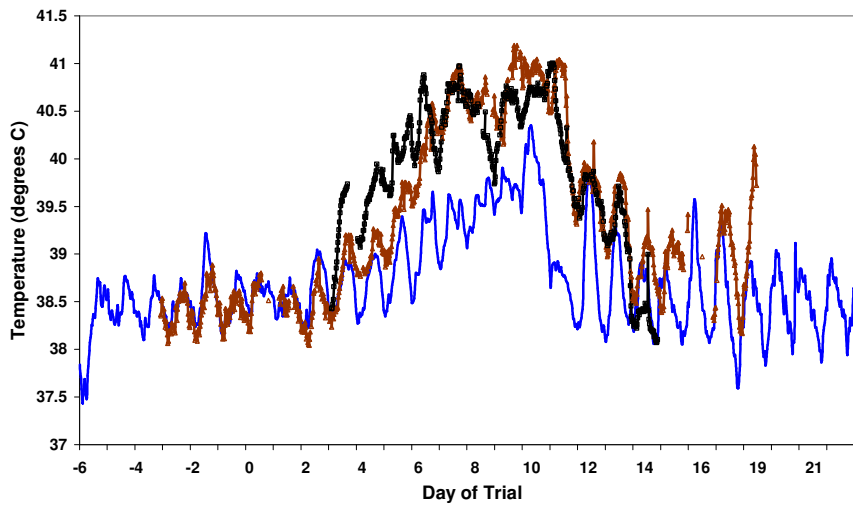
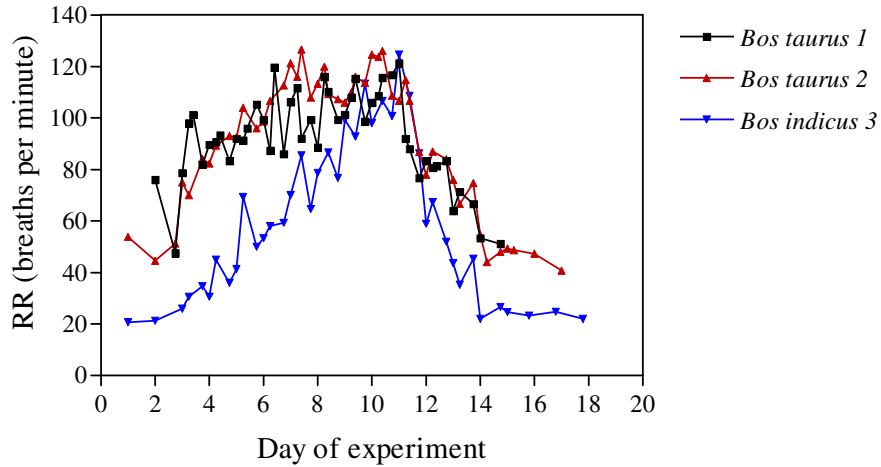
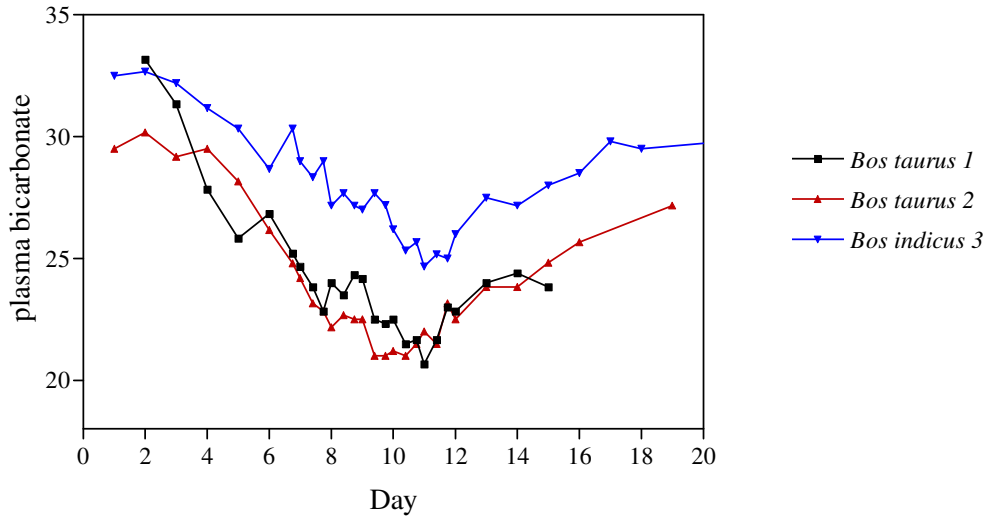


Figure 3: Mean respiratory rates for the cattle in the three heat experiments.



**Figure 4: Mean bicarbonate concentration (mmol/L) for the three heat experiments, measured on jugular venous blood.**



*Sheep experiment (Stockman et al 2006)*

In the sheep experiment there were two heat periods, to mimic the fluctuations of temperature commonly experienced on ships (Figure 5). The Merino sheep did respond with elevated core body temperature, but the core temperature of the Awassi rams did not rise above 39.5 °C, and these differences in tolerance to the conditions were reflected in the respiratory rates with Merino sheep developing very fast respiration in the hot conditions. There was less impact on the feed intake of the sheep compared to the cattle, and acid base balance rapidly returned to normal after the hot conditions.

**Figure 5: Wet bulb temperatures of the climate-controlled rooms, and unheated control room, for the duration of the sheep experiment.**

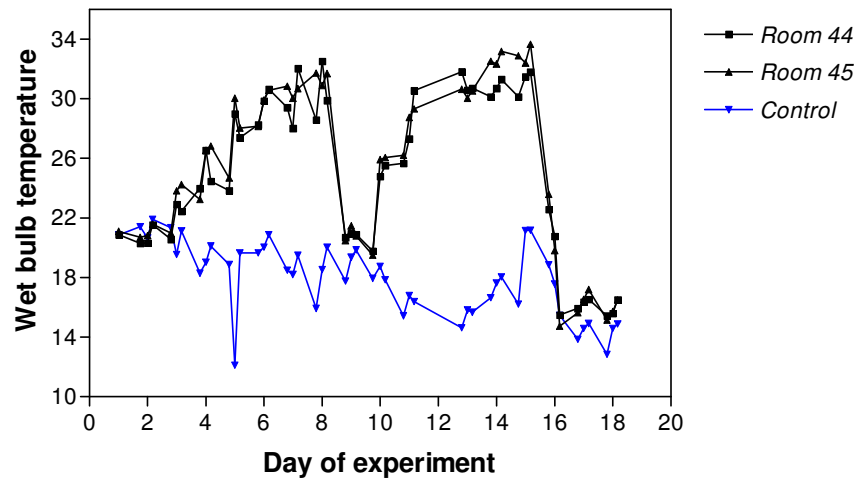


Figure 6: Core body temperatures (two-hourly averages) of Awassi and Merino sheep in the climate controlled rooms for the duration of the experiment. The hottest periods were days 6-9 and days 11-15

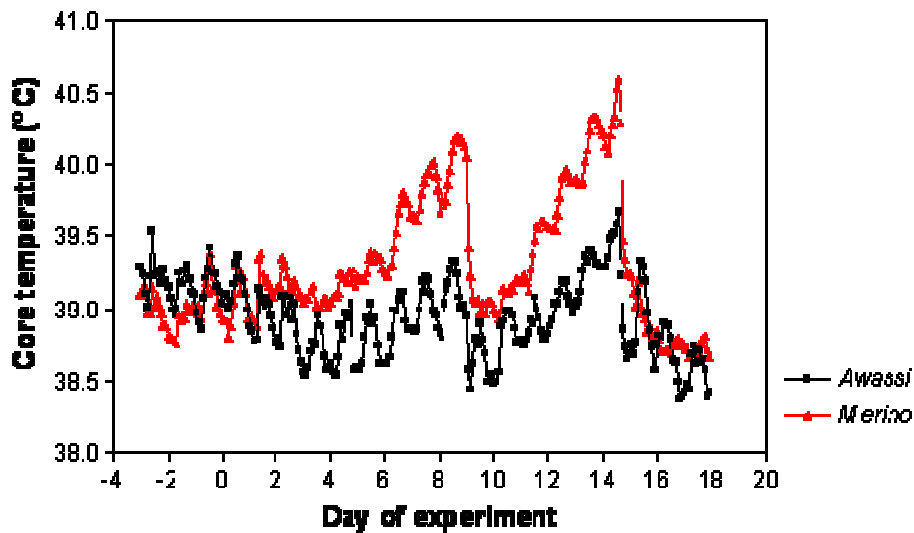
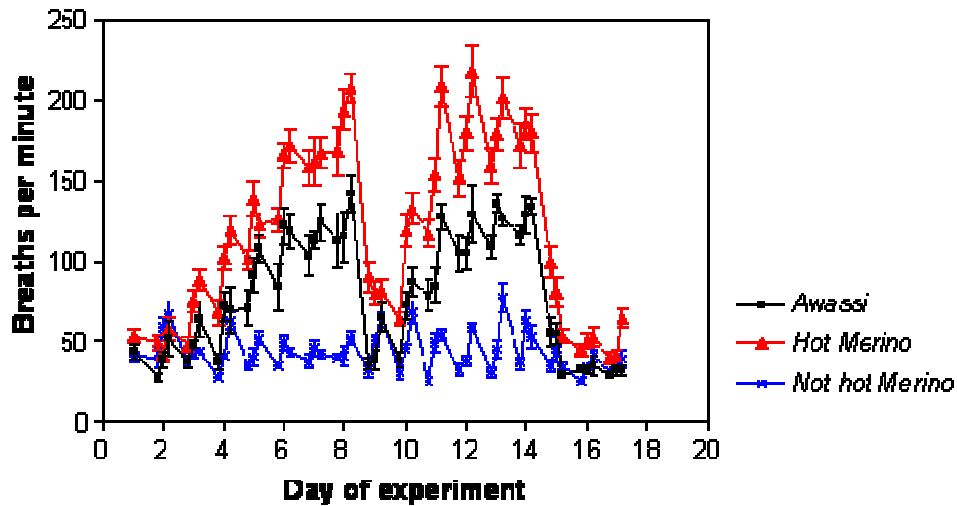


Figure 7: Respiratory rate of the Awassi and Merino sheep in climate controlled rooms and Merino wethers in the control room during the experiment (mean SEM).



There were no sustained blood gas alterations in the sheep.

#### *Electrolyte supplementation (Beatty et al 2007)*

From the results on the initial experiments, one water-based electrolyte supplement was trialled in the cattle but not the sheep. Experiments were conducted initially in the climate controlled rooms, and then on a commercial shipment. The cattle drank the supplemented water well, and with no ill effects, and drank more than the unsupplemented cattle. There was no indication that there was a difference in body temperature, nor in feed intake, but the supplemented animals weighed significantly more than the unsupplemented animals after the shipboard voyage, and there were differences in electrolyte and acid base values between the groups. However, it was not apparent from this work that there were repeatable health benefits of supplementing the animals with that particular electrolyte mix.

## References

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